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PCT

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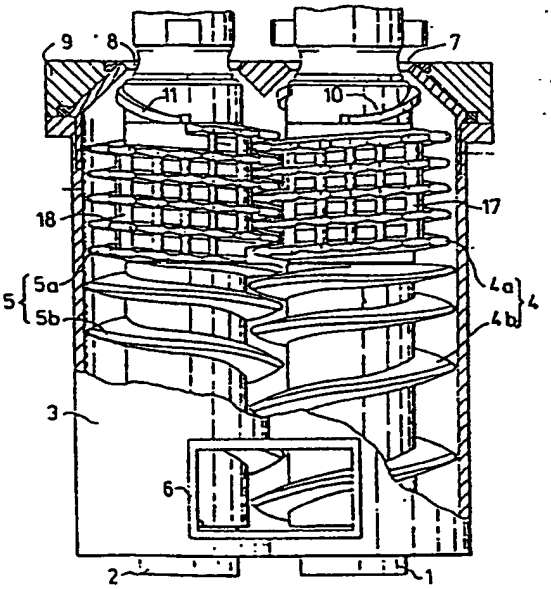
(54) Title: AN APPARATUS FOR DEFIBRATING AND, AT THE SAME TIME, CONDITIONING CELLULOSIC MATERIAL

(57) Abstract

An apparatus for defibrating and conditioning cellulosic material having a concentration such that said material does not flow, said apparatus comprising at least two rotatable screws (4, 5) which are parallel with one another in a casing (3), provided with an inlet and an outlet. The screws are arranged to mesh together to work the material. Some of the helix-turns exhibit recesses (13, 14) and in the axial direction of the screws are fixedly arranged elements (17, 18) adapted to engage the recesses of the mutually co-acting screws as they rotate.



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AN APPARATUS FOR DEFIBRATING AND, AT THE SAME TIME, CONDITIONING CELLULOSIC MATERIAL

The present invention relates to an apparatus for defibrating and, at the same time, conditioning cellulosic material, in which cellulosic materials of such concentration that it does not flow, is subjected to rolling, kneading, compression and mixing operations. The elements of the known apparatus include a casing provided with an inlet and an outlet, in which casing there is arranged at least two screws or worms which are coupled together for common rotation and the helices of threads of which mesh together to work the cellulosic material located therebetween. Each screw comprises a first axial section whose pitch decreases in a direction from the inlet end of the casing. This first section of the screw merges with a second axial section of constant pitch, the pitch of the second axial section being smaller than the smallest pitch of said first axial section. The helix of each screw is provided with one or more recesses in the circumference thereof in the region of one or more turns of the helix located in the region of the outlet, in a manner to form dogs, teeth or arcuate recesses in which separate portions of the treated material are subjected to local, radial, compression against an opposing land or groove-bottom. An arrangement of the aforedescribed type is known from, for example, the Swedish Patent Specification 333 095.

In the known apparatus the cellulosic material is subjected to a rolling, kneading and mixing operation between the side surfaces of the helices or threads, whereby the material is separated into individual fibres to provide a fibre of the length desired with regard to the desired properties of the final product. The recesses in the helices also afford the advantage that the material can be more readily drawn down between the two screws, where said material is subjected to a local, radially directed compression in the space defined by the edge surfaces of one

of the helices and the groove-bottom or land of the other helix. The result hereof is that the material is not only further defibrated, but also that it is subjected to a conditioning process. By conditioning is meant in this context that the exposed fibres are imparted a permanent crimping or curling such as to provide a felt of randomly oriented fibres. This in turn means that the mass of fibres obtains a higher specific volume. Such a mass can be used for many purposes, such as in the manufacture of fluff for use as an absorption material in babies napkins or diapers, and in particular for the manufacture of air-permeable sheets of material for the manufacture of, for example, multilayer sacks or bags. In the lastmentioned case, the permanent crimp imparted to the fibres also affords the advantage that the final paper product obtains an increased stretchability and an increased tear factor of 20-40 % to to-25 % respectively. When manufacturing, for example, multilayer bags or sacks, the ability of the inner layers of paper to stretch without rupture is desirable, so that the outer layers of the bag are able to withstand the loads to which the bag or sack is subjected during use.

Although the known apparatus affords important advantages, as beforesaid, tests carried out during the development of said apparatus have shown that the radial compression to which the cellulosic material is subjected as a result of the recesses in the helices, is often insufficient to provide an end product of the desired quality. This is particularly the case when it is necessary to reduce the area of the recesses, in order to increase the capacity of the apparatus. Thus the conditions under which satisfactory radial compression of the cellulosic material can be obtained, i.e. the provision of recesses of given size, and under which the capacity of the apparatus can be increased, conflict with one another. An object of the present invention is to solve the problem created by these conflicting conditions, which can be explained in the following manner.

The more pronounced the recesses in the helices of

the screws the less the screws are able to convey the material and the lesser the material is compressed axially in the region adjacent the outlet of the apparatus. For example, if the pressure exerted on the material is too low, i.e. the recesses are too large, the capacity of the apparatus is reduced considerably. In order to increase the transporting capacity of the screws, and therewith the production capacity of the apparatus, it is necessary to reduce the size of the recesses. The result hereof, however, is that the desired radial compression of the material is reduced. In practice the solution has been in the form of a compromise in which neither the capacity of the apparatus nor the radial compression of the material has been as high as one could desire.

The aforementioned problems, which have limited the utility of the apparatus in general practice, have been solved with the present invention. The problem has been eliminated in accordance with the concept of the invention by providing the groove-bottoms or land areas of the screws with beads which, as the screw rotates, pass into the recesses in a respective helix or thread of an opposing screw. These beads reduce the amount of cellulosic material which tends to accompany the rotary movement of the helices during excessively slow transportation of the material in the direction of movement. In this way there is obtained an increase in the axially directed pressure, i.e. an increase in the transport effect of the screws whilst maintaining the size of the recesses in the helices. In fact, the present invention enables the recesses in the helices to be made larger than was previously the case, without impairing the capacity of the apparatus.

A further advantage afforded by the beads is that they have been found to radially compress the cellulosic material in a manner not previously known, this radial compression occurring between the beads and the edge surfaces of the recesses in an opposing helix-turn of the screw. This further compression of the material provides

further conditioning effect and therewith an increased capacity of the apparatus. Thus, the invention relates to an apparatus for defibrating and conditioning cellulosic material having a concentration such that said material does not flow, comprising at least two screws which are arranged parallel with each other in a casing provided with an inlet and an outlet and which mesh with each other for working the material, and the helices of which screws exhibit recesses on the circumferences of at least one or two of the turns of said helices to form teeth between said recesses, characterized in that beads which extend parallel with the screw axis are arranged on each screw between the turns of that part of a respective helix provided with said recesses.

In order that the present invention shall be more readily understood and further features thereof made apparent, exemplary embodiments thereof will now be described with reference to the accompanying drawings, in which

Figure 1 is a plan view of an apparatus for defibrating and conditioning cellulose pulp having two mutually meshing screws provided with beads in accordance with one embodiment of the invention,

Figure 2 is a cross-sectional view taken on the line II-II in Figure 1,

Figure 3 is a cross-sectional view of a defibrating and conditioning apparatus of the type in question with the beads of said helices being constructed in accordance with a further embodiment, and

Figure 4 illustrates in perspective a section of a helix of screws in a defibrating and conditioning apparatur according to the invention, provided with beads in accordance with a third embodiment of the invention.

In Figures 1 and 2 the references 1 and 2 identify two shafts which are arranged for rotation in parallel with each other in a housing 3. The shafts are connected and driven for rotation in unison in mutually opposite direc-

tions, for example by means of a gear system not shown. Each of the shafts 1,2 carries thereon a respective helix 4 and 5 which extends along the major portion of the length of the shafts within the housing 3. The helices may be removably fixed to the shafts in a manner not shown in detail. The cross-sectional configuration of the housing is adapted to the mutually meshing helices 4,5 in a manner such that the inner surface of the housing conforms substantially to the imaginary surface described by the helices as they rotate. The housing is provided at one end thereof with an inlet opening 6 for the cellulosic material to be treated, and at its other end with a ring-shaped outlet opening 7,8 encircling each of the two shafts 1,2. In this respect the end wall 9 of the housing is drawn in towards the outlet opening to provide a certain damming of the cellulosic material as it leaves the housing. The outlet openings 7,8 have a controllable through-flow area, for example by arranging for the end wall 9 to be displaceable in the axial direction of the housing. Such a construction is the object of the Swedish Patent Specification 314 288. In the inwardly drawn space, which comprises the end wall 9, the two shafts 1,2 support a separate screw 10 and 11 respectively which mutually co-act to discharge the material through the outlet openings 7 and 8.

Each helix 4,5 comprises a forward and a rearward section 4a, 5a and 4b respectively. The rearward sections 4b,5b of the helices 4,5 extend from the infeed end of the housing to a region which is located approximately at the centre of the housing, where said rearward sections merge with the forward sections 4a,5a of respective helices to form continuous screw threads on the shafts. The pitch of respective helix sections decreases progressively from said inlet end, whilst the pitch of the helix sections 4a, 5a is constant although smaller than the smallest pitch of helix sections 4b,5b, i.e. smaller than the pitch between the two last helix-turns of the rearward helix sections. The inlet opening 6 of the housing 3 is thus located above

the screws at a location at which the pitch of the helices is greatest.

Both of the forward helix sections 4a,5a have been provided with recesses 13,14 which are uniformly distributed along the whole of said forward sections to form teeth or cogs 15,16 therein. In the illustrated embodiment, these recesses have the form of substantially triangular notches, the depth of which comprises a part of the radial extension of a respective helix.

The helices 4,5 have a cross-sectional shape similar to an outwardly tapering, substantially parallel trapezium. The angle at which the side surfaces of the helices are inclined to the radial plane may be from 5 to 15°, and is preferably 10°. The relationship between the pitch of respective rearward helix sections 4b,5b and the cross-sectional dimensions is selected so that there is no appreciable compression of the cellulosic material between corresponding surfaces of mutually meshing helix sections. On the other hand, the pitch and cross-sectional dimensions of the forward helix sections 4a,5a are carefully co-ordinated to provide compression of material between mutually opposing side surfaces of mutually meshing helix sections and between the teeth (15 or 16) of one helix section (4a or 4b) and the groove-bottom or land area of the other helix section. The distances overall are selected so that the risk of shortening the fibres as a result of their being cut is eliminated. The distances between mutually opposing surfaces is preferably more than 2 mm.

The circumferential surface of the crests of the helix-turns of the forward helix sections 4a,5a has a width which comprises only a fraction of the pitch of the helices. This is of great importance with respect to the manner in which the crest of a helix-turn enters the space between two adjacent helix-turns of an opposing screw filled with cellulosic material. The ratio between the depth of the helix and the pitch thereof with respect to the forward helix sections 4a,5a is also of importance with

respect to the cohesion of the cellulosic material to the screw. In the examplary embodiment, this ratio is approximately 2 : 1. The ratio is preferably not lower than 3 : 2.

Arranged opposite each respective recess 13,41 in a helix section of the forward helix sections 4a,5a is a bead 17,18 mounted on a respective shaft 1,2. Each of the beads extends parallel with the shaft from turn to turn of the helix along the whole of a respective forward helix section radially adjacent the bottom of the corresponding recess. The height and width of the beads may be between 2/3 - 1/3 and 1/4 - 1/2 of the depth of the helix, and in the examplary embodiment are 1/3 and 1/4 of said depth.

The mode of operation of the apparatus is as follows. Subsequent to starting the screws, cellulosic material is fed into the housing 3 through the inlet opening 6. At that point of time in which it is charged to the apparatus, the material has a concentration or consistency of more than approximately 12.5 % solid substance, preferably above 25 %. In the region of the rearward helix sections 4b,5b the material is advanced and compacted in a manner such that the land areas of the forward helix sections 4a,5b are filled (by land area is meant the groove between consecutive helix-turns). As a result of its cohesion with respective helices and because the material, as a result of its consistency, is packed to a coherent mass, the material enclosed in the land areas rotates constantly together with the forward helix sections. Thus, the cellulosic material is forced to pass repeatedly through the spaces defined between mutually opposing side walls of the helices. The speed at which the cellulosic material passes through the working zone is determined by a) the infeed speed, b) the outfeed speed which in turn is determined by the through-flow area of the outlet openings, c) the speed at which the screws rotate, and the properties of the cellulosic material being treated. The longer the cellulosic material remains in the apparatus, the higher the working effect. Thus, it is important that the through-flow area of the outlet openings

can be controlled, in order that a specific cellulosic material obtains optimal properties when treated in the apparatus.

Since the peripheral speed is much greater at the circumference of the helices than at the bottom of the land area or groove defined by adjacent helix-turns, the cellulosic material located within the region of each recess 13,41 in the forward helix sections 4a,5a will agglomerate and be pressed in a radial direction towards the opposing groove bottom and be subjected to a rolling and shearing treatment process. The radially directed compression and working of the cellulosic material in the neighbourhood of the recesses 13,14 results in that the cellulosic material is not only defibrated but that the exposed fibres are also imparted a permanent crimp and therewith become matted in an irregular array. This means that the treated pulp obtains a high specific volume, which renders it particularly suitable for use in a plurality of fields, for example as absorption material in babies napkins (diapers) and the like.

A highly specific working effect is obtained by means of the beads 17,18 arranged on the shafts 1,2. As the screws rotate, the beads fit into the recesses on the helix section of an opposing screw. In this way the amount of cellulosic material which tends to accompany the helix during its rotation during an excessivly slow movement in the transport direction is decreased. As a result hereof, an increase is obtained in the axially extending force, i.e. an increase in the transport effect of the screws. The provision of the beads 17,18 has therefore meant that the examplary apparatus can be provided with much greater recesses than would otherwise have been possible, without reducing the transporting capacity of the screws. The resultant effect hereof is an increased radial compression of the cellulosic material whilst retaining a high flow of material through the apparatus, which provides a well defibrated and conditioned pulp with a strongly reduced

fibre-knot content and whilst retaining a high capacity.

The following examples with tables enable a comparison to be made between the reduction in the fibre-knot content of a sulphate knot-pulp obtained in practical tests by means of apparatus provided with two meshing screws, of which one was provided with beads in accordance with the invention, whilst the other lacked such beads. In other respect the apparatus were identical. The fibre-knot contents are given in percent by weight in the tables.

EXAMPLE

A sulphale knot-pulp having 4,8 percent by weight fibre-knots and having a dry content of approximately 30 % was divided into two equal parts. One of said parts was fed into an apparatus provided with said beads, while the other part of said pulp was fed into the apparatus which was not provided with beads. The amount of pulp charged to the apparatus per unit of time, the number of revolutions and the area of the outfeed gap of the apparatus and other conditions were the same for both apparatus.

The following results were obtained.

The apparatus in which no beads were provided

Fibre-knot content of the untreated pulp	Fibre-knot content of the treated pulp	Reduction in the fibre-knot content	Energy consumed per ton of pulp
4.8 %	1.8 %	62.5 %	236 kWh

The apparatus provided with beads

Fibre-knot content of the untreated pulp	Fibre-knot content of the treated pulp	Reduction in the fibre-knot content	Energy consumed per ton of pulp
4.8 %	0.98 %	79.5 %	323 kWh

The exemplary apparatus can be modified in many respects within the scope of the invention. For example, when the beads are arranged on the screw shafts as described in the above embodiment, they may be mounted on both

the screw shaft and the helices or only on said shaft or said helices.

It is also possible to arrange the beads on the screw shafts with different radial extents or at a distance from the screw shafts. Figure 3 shows one such embodiment in which the beads 19,20 are arranged at a distance from the screw shafts 1,2 in a manner such that they project slightly into the recesses 13,14 in the helix sections 4a, 5a.

It is also possible to arrange the beads in one of the aforementioned embodiments such that said beads are displaced laterally so that they are located between the recesses instead of opposite the same. Figure 4 illustrates the beads (here reference 21) in such an embodiment, the associated helix section 4a being dismantled and separated from the screw shaft. It will be understood that the beads in all of the aforementioned embodiments can suitably be arranged around the screw axis with the same division as the recesses in a respective helix.

When the beads extend along the screw shaft along the whole distance between mutually adjacent helix-turns, as with the first embodiment for example, the axially, sequential beads are conveniently formed as a coherent, rod-like units, and the helices are suitably provided with through-openings into which the rods can be inserted and locked firmly in their mounted position. This embodiment enables the rods to be readily replaced when necessary. It is also possible, however, to arrange the rods or beads along only a part of the distance between mutually adjacent screw turns.

In further embodiments of the beads, said beads or rods can be made mutually greater or smaller in direction towards the outlet of the apparatus and/or may be provided with serrated surfaces in order to increase the friction against the cellulosic material. For the same purpose, the edge surfaces of the teeth formed on respective helices by said recesses may also be serrated. These

serrated surfaces may suitably be arranged on elements removably mounted on the edge surfaces of the beads or the teeth, the elements of one bead or tooth abutting the element on an opposing bead or tooth. One advantage afforded hereby is that the serrated surfaces can be readily exchanged for serrated surfaces of a different type or size, or can readily be replaced when worn. For the same purpose the beads or rods may also be removably mounted on the screw shaft and/or respective helices.

CLAIMS:-

1. An apparatus for defibrating and conditioning cellulosic material having a concentration such that said material does not flow, said apparatus comprising at least two rotable screws which are arranged parallel with one another in a casing (3) provided with inlet (6) and outlet (7,8), said screws being arranged to mesh together to work said material and the helices (4,5) of which screws exhibit recesses (13,14) on the periphery of at least some of the helix-turns to form teeth (15,16) between the recesses, wherein between the helix-turns of these parts of respective helices provided with recess characterized therein that in the axial direction of the screws, are fixedly arranged elements (17,18; 19,20; 21) adapted to engage the recesses of the mutually co-acting screws as they rotate.

2. An apparatus according to claim 1, characterized in that the beads are arranged on the screw shaft and are fixedly mounted thereon and/or on respective helices.

3. An apparatus according to claim 1, characterized in that the beads are arranged at a radial distance from the screw shaft and are fixedly mounted on an associated helix.

4. An apparatus according to anyone of claims 1-3, characterized in that the beads extend along the screw shaft along the whole distance between mutually adjacent helix-turns.

5. An apparatus according to anyone of claims 1-3, characterized in that the beads extend along the screw shaft along part of the distance between mutually adjacent helix-turns.

6. An apparatus according to anyone of claims 1-4, characterized in that the beads extend along the screw shaft through openings in an associated helix.

7. An apparatus according to anyone of the preceding claims, characterized in that the beads are arranged along the screw shaft along the whole of the axial extent of the part of the helix provided with said recesses.

8. An apparatus according to anyone of claims 1-6, characterized in that the beads are arranged along the screw shaft along part of the axial extent of the part of an associated helix provided with said recesses.

9. An apparatus according to anyon of the preceding claims, characterized in that the beads are mutually larger or smaller in a direction towards the outlet of the apparatus.

10. An apparatus according to anyone of the preceding claims, characterized in that the beads are arranged around the screw shaft with the same division as the recesses in the helix, each bead extending through a radius to the screw shaft through one of the recesses.

11. An apparatus according to anyone of claims 1-9, characterized in that the beads are arranged around the screw shaft with the same division as the recesses in the helix, each bead extending through a radius to the screw shaft between mutually adjacent recesses.

12. An apparatus according to anyone of the preceding claims, characterized in that the beads or rods and the edge surfaces on the prominotories forming said recesses on an associated helix have serrated surfaces or the like thereon.

13. An apparatus according to anyone of the preceding claims, characterized in that the serrated surfaces are arranged on elements which are removably mounted on the beads and/or on the edge surfaces of the prominotories, said abutting one another.

14. An apparatus according to anyone of the preceding claims, characterized in that the beads are removably mounted on the screw shaft and/or on associated helix.

Fig. 1

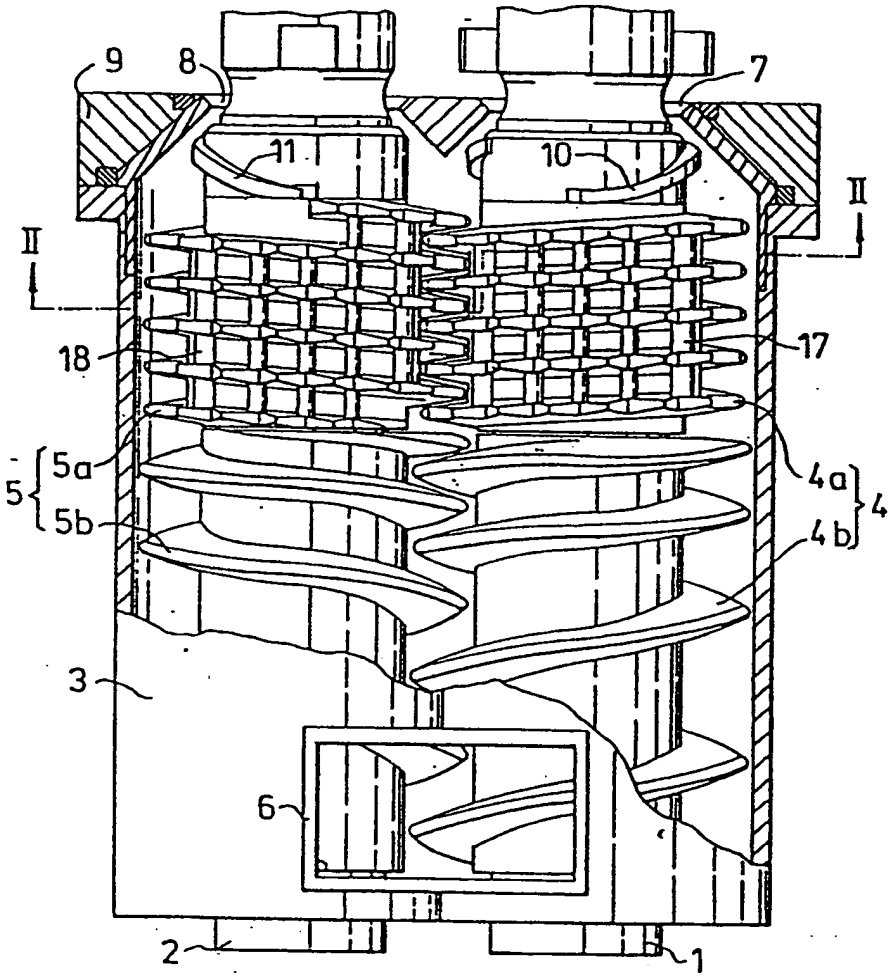


Fig. 2

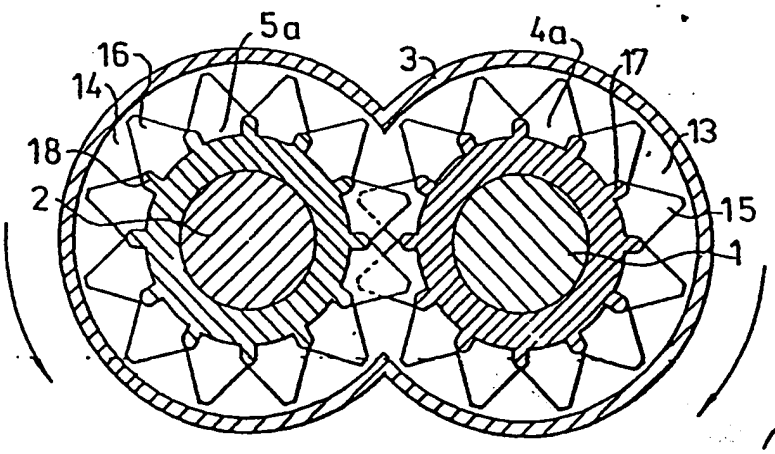


Fig. 3

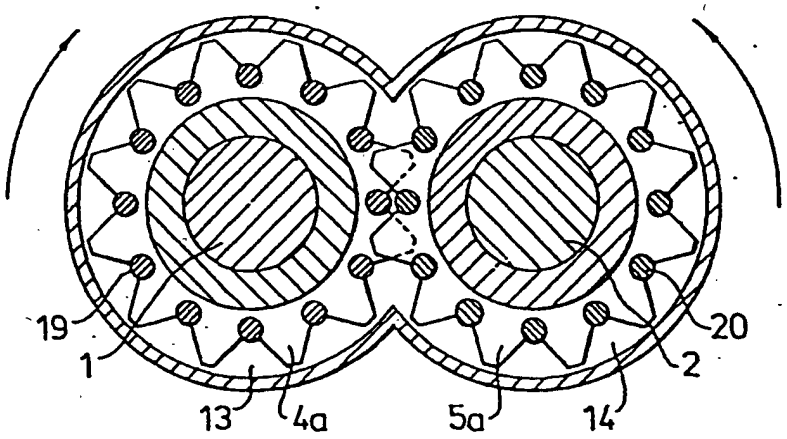
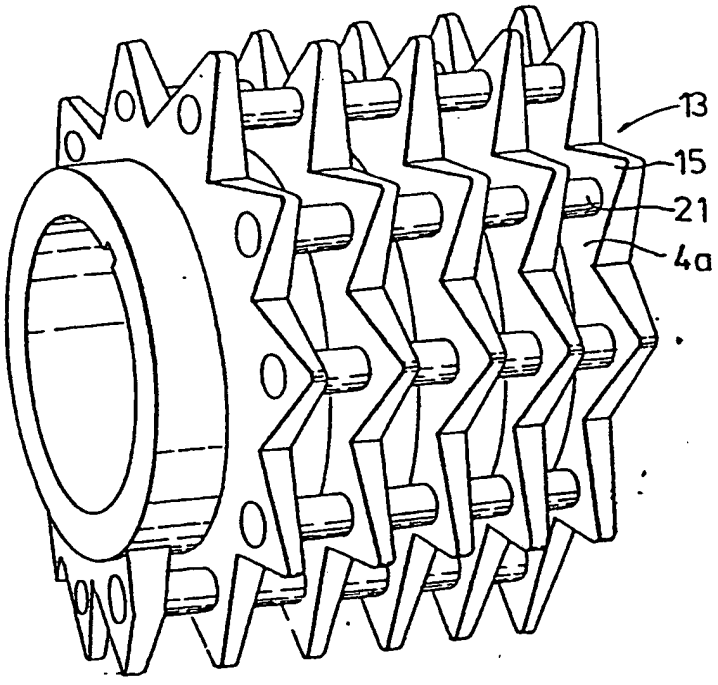


Fig. 4



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE78/00077

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

D 21 B 1/04, D 21 D 1/34, B 01 F 7/08, B 65 G 33/18

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC	B 01 F 3/12, 3/18, 7/08, 7/24, 9/16; B 65 G 33/18; D 21 B 1/00-1/14, 1/30-1/36; D 21 D 1/20, 1/34-1/38; F 04 C 1/10

.../...

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [5]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	DE, C, 359 954 published 1922, Sept 28, Allgemeine Elektricitäts-Gesellschaft in Berlin	1
A	DE, C, 485 354 published 1929, Oct 30, Allgemeine Elektricitäts-Gesellschaft in Berlin	
X	SE, B, 333 095 published 1971, March 1, AB Calor & Sjögren	1
A	US, A, 3 690 623 published 1972, Sept 12, GKN Windsor Ltd	
A	US, A, 2 778 482 published 1957, Jan 22, Werner & Pfleiderer Maschinenfabriken	
A	GB, A, 1 199 721 published 1970, July 22, Nauchno-Issledovatelsky Institut Shinnoi Promysh-Lennosti	

* Special categories of cited documents: [15]

"A" document defining the general state of the art

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"L" document cited for special reason other than those referred to in the other categories

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but on or after the priority date claimed

"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [1]	Date of Mailing of this International Search Report [2]
1979-02-15	1979-02-27
International Searching Authority [3]	**Signature of Authorized Officer [20]**
Swedish Patent Office	Leif Gustafsson

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

II Continuation classification system.

Deutsche Klassen: 12E 4/50, 50C 4/01, 8/47, 17/01, 50F 2/01, 2/30, 55A 3/01, 4, 5/01, 5/50, 7, 55C 11/01, 12, 81E 23.

US classification: 198-64, -213, -214, -215, -216, -217; 241-28, -47, -52, -53, -94, -98, -99, -100, -101, -198, -199, -217, -218, -219, -235, -246, -247, -266, -267, -268, -269, -283, -284, -285, -300; 259-97, -104, -192, -194, -195.

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers _____, because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers _____, because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.